Journal of Entomology and Zoology Studies

Available online at www.entomoljournal.com

E-ISSN: 2320-7078
P-ISSN: 2349-6800
www.entomoljournal.com
JEZS 2020; 8(4): 487-495

Received: 16-05-2020
Accepted: 18-06-2020

Viswanadha Raghuteja Puvvala
College of Horticulture,
Dr. Y.S.R. Horticultural University,
Venkataramannagudem, West
Godavari, Andhra Pradesh, India

N Emmanuel
College of Horticulture,
Dr. Y.S.R. Horticultural University,
Venkataramannagudem, West
Godavari, Andhra Pradesh, India

A Sujatha
College of Horticulture,
Dr. Y.S.R. Horticultural University,
Venkataramannagudem, West
Godavari, Andhra Pradesh, India

K Umakrishna
College of Horticulture,
Dr. Y.S.R. Horticultural University,
Venkataramannagudem, West
Godavari, Andhra Pradesh, India

CP Viji
College of Horticulture,
Dr. Y.S.R. Horticultural University,
Venkataramannagudem, West
Godavari, Andhra Pradesh, India

TSSK Patro
College of Horticulture,
Dr. Y.S.R. Horticultural University,
Venkataramannagudem, West
Godavari, Andhra Pradesh, India

Corresponding Author:
Viswanadha Raghuteja Puvvala
College of Horticulture,
Dr. Y.S.R. Horticultural University,
Venkataramannagudem, West
Godavari, Andhra Pradesh, India

Impact of IPM and non-IPM practices on sucking pest complex and natural enemies of okra (*Abelmoschus esculentus* L.) pests

Viswanadha Raghuteja Puvvala, N Emmanuel, A Sujatha, K Umakrishna, CP Viji and TSSK Patro

Abstract
Studies on the influence of IPM and non-IPM practices were carried out during *rabi* season 2018-19 at College of Horticulture, Venkataramannagudem, West Godavari district, Andhra Pradesh with an objective of examining their influence on sucking pest complex and natural enemies of okra pests. The results revealed that the mean population of jassids (*A. devastans devastans*) was 2.82 ± 0.39 number per okra leaf in IPM plot, whereas in the non-IPM plot it was 5.43 ± 1.20 number per leaf. The maximum mean population of whitefly (*B. tabaci)* was recorded in okra grown in control plot with 4.54 ± 2.24 number per leaf followed by non-IPM plot with 1.17 ± 0.22 number per leaf and 0.42 ± 0.08 number per okra leaf in IPM plot of okra. The minimum average population of aphids was observed in okra grown in IPM plot with 0.27 ± 0.11 number per leaf followed by non-IPM plot with 1.11 ± 0.40 number per leaf, whereas in control plot it was 2.79 ± 1.23 number per leaf. The average population of two spotted mites per sq.cm leaf area was 0.54 ± 0.28 number in IPM plot, whereas it was 1.03 ± 0.41 and 4.04 ± 2.71 number per sq.cm leaf area in non-IPM and control plots of okra respectively. The results further revealed that the mean population of natural enemies *viz.*, spiders and coccinellid beetles were found 3.58 ± 2.39 number per plant in IPM as compared to that of 2.70 ± 2.39 number per plant in non-IPM plot, while in the control plot of okra the mean number of natural enemies recorded were 3.22 ± 2.48 number per plant.

Keywords: IPM plot, Non-IPM plot, okra, jassids, whiteflies, aphids, mites and natural enemies

Introduction
Okra (*Abelmoschus esculentus* (L.) Monech) is a rich source of dietary fiber, antioxidants, ascorbic acid and folate. Mucilage from okra has been reported to be effective as blood volume expander and has the potential to alleviate renal disease, reduce proteinuria and improve renal function (Siemonsma and Kouame, 2004) [11].

The production and productivity of okra is often limited by incidence of sucking pests with 40 to 56 percent of yield loss in okra is due to leafhoppers resulting in reducing 49.8 and 45.1 percent losses in plant height and number of leaves, respectively (Rawat and Sadu, 1973) [9] which de-sap the plants and make them weak. The extent of loss caused by aphids and leafhoppers in the early stage varied between 50 to 55 percent (Chaudhary and Dadeech, 1989) [2].

Over reliance on synthetic insecticides and its indiscriminate use against insect pests over last four decades has resulted in many negative consequences, *viz.*, Resurgence, Resistance and Residual aspects and is also toxic to beneficial insects of okra ecosystem. To minimize the pesticide load in okra, various IPM modules have been worked out with reference to safety of the consumers and producers as well as to ensure food quality.

IPM is an effective, environmentally safe approach to pest management as it provides protection for beneficial insects as well as prevention of secondary pest outbreaks and resurgence (Preety and Bharucha, 2015) [7] and encourages sensible use of insecticides which is essential for natural enemy conservation resulting in keeping the pest population below economic threshold level.

Materials and Methods
The experiment was conducted at college farm, College of Horticulture, Venkataramannagudem to examine the influence of IPM, non-IPM and control practices on

sucking pest complex and natural enemies of okra (*Abelmoschus esculentus* (L.) Monech) pests during *rabi* season 2018-19. Okra seeds of variety "Arka Anamika" were sown in IPM, non-IPM and control plots of 25m x 20 m size with a spacing of 45 cm between rows and 60 cm between plants.

The schedule of IPM plot followed was

1. Deep ploughing was done thoroughly with a tractor drawn cultivator and evenly levelled after removing all the stubbles and weeds.
2. Maize was sown as border crop. Raised seed beds for raising the crop were made 10 days after sowing of maize.
3. Reflective Plastic Mulch (Sheet gauge) of 25 microns silver black, 4 feet width long bundle was laid on the beds which reflects sunlight against whitefly, enhances crop growth and controls weeds.
4. Okra variety, "Arka Anamika" was sown 21 days after sowing of maize in triangular system with a spacing of 60 x 45 cm with row to row on raised seed beds.
5. Phytosanitary measures such as collection and destruction of infested plant parts was done regularly. Marigold seedlings were transplanted with a spacing of 60 x 60 cm as trap crop after 10 days of sowing of okra in 1:10 ratio.
6. Installation of yellow sticky traps @ 2 / 500 sq.m was done at 15 days after of sowing of okra against sucking pests.
7. Installation of light trap @ 1/ 500 sq.m was done at 15 days after of sowing of okra against lepidopteran pests.
8. Installation of sex pheromone trap @ 1/500 sq.m was done at 45 days after sowing of okra against fruit and shoot borer.
9. Erection of bird perches @ 1/500 sq.m was done at 45 days after sowing of okra. Need based application of botanicals and bioagents *viz.*, NSKE 5 per cent @15 DAS, neem oil @ 3 ml/l at 30 DAS, Sweet flag aqueous extract 5 per cent @ 45 DAS, *Beauveria bassiana* @ 5 g/l at 60 DAS, *Bacillus thuringiensis*@ 1 g/l at 75 DAS, imidachloprid 17.8 SL @ 0.3 ml/l at 90 DAS were carried out on sequential basis.

Non-IPM plot

In non-IPM plot of okra application of chemicals was carried out on sequential basis as per the schedule given below.

A. Sucking pests

1. Spraying of Imidachloprid 17.8 SL@ 0.25 ml/l at 15 days after sowing.
2. Spraying of Lambda cyhalothrin 5 EC @ 1ml/l at 30 days after sowing.
3. Spraying of Thiomethoxam 25WG @ 2ml/l at 45 days after sowing.

B. Borer pests

1. Spraying of Flubendiamide 480 SC @ 1ml/l at 60 days after sowing.
2. Spraying of Buprofezin 25 SC @ 1ml/l at 75 days after sowing.
3. Spraying of Chlorantraniliprole 18.5 % SC @ 0.25ml/l at 90 days after sowing.

Control plot

In control plot of okra no chemical was applied in connection to pest control except agronomical practices.

All the three plots were monitored strictly following the pest scouting system. Population of sucking pests *viz.*, jassids, whiteflies, aphids and mites were recorded by visual observation on both surfaces of the leaf on three randomly selected leaves from top, middle and bottom canopy of the plant at weekly intervals starting from 15 days after sowing till crop maturity and depicted as population per leaf or unit area. Data was also recorded on natural enemy population of okra pests *viz.*, spiders and coccinellids (grubs and adults) at weekly intervals and taken as natural enemy count/plant and categorization was observed by sampling method.

Pest incidence and natural enemy population were recorded from 10 per cent of sampled plants in IPM, non-IPM and control plots of okra. The mean population of sucking pests and natural enemies in IPM plot was compared to that of non-IPM and control plots of okra and the data was then analyzed by using paired t-test method with SPSS 12.0 version pioneered by Gosset (1908) and later on developed and extended by Prof. R. A. Fisher.

Results and Discussion

Studies were carried out during the year 2018-19 to examine the impact of adopting IPM, non-IPM and control practices for controlling various insect pests including sucking complex as well as predatory activity on okra. Among insect pests, Jassids, *Amrasca devastans devastans*, Whiteflies, *Bemesia tabaci*, Aphid, *Aphis gossypii* and red spider mite *Tetranychus utricae* were recorded, while among natural enemies spiders and coccinellids (grubs and adults) were recorded. The results on each insect are separately presented under respective headings.

Jassid, *Amrasca devastans devastans*

The data shown in the table 1 and figure 1, revealed that the population of jassid (*A. devastans*) on okra grown in IPM plot decreased at much faster level than the non-IPM plot, whereas in the control plots the population level increased with standard meteorological week (SMW). The mean population of jassids was found to be 2.82 ± 0.39 number per leaf in IPM plot of okra as compared to that of non-IPM plot with 5.43 ± 1.20 jassids per leaf, which was 53.40 percent higher than the IPM plots. There was a significant difference in number of jassids per okra leaf between IPM and non-IPM plots as per the t-statistical value depicted in the table 2. The mean population of jassid was found 8.46 ± 2.77 number in control plot which was 63.08 percent more than in IPM plot. Further it was found that the number of jassids per leaf in control plots of okra was 6.08 times more than the IPM plot and significant as per the t-statistical value given in the table 3.

Whitefly, *Bemesia tabaci*

The data show in the table 4 and figure 2, indicated that the mean population of whitefly (*B. tabaci)* was low of 0.42 ± 0.08 number per leaf in IPM plot of okra, while in non-IPM plots it was 1.17 ± 0.22 number per leaf, which was 39.19 percent more than IPM plots. However, there exists a significant difference in whitefly population per okra leaf between IPM and non-IPM plots as per the t-statistical value given in the table 5. The mean population of whiteflies was found 4.54 ± 2.24 number per leaf in control plot which was 82.86 percent more than that of IPM plot as per the t-statistical value given in the table 6.

Aphid, *Aphis gossypii*

The minimum mean average population of *A. gosypii* was recorded in IPM plots with 0.27 ± 0.11 number per leaf as compared to that of non-IPM plot (1.11 ± 0.40 number). However the peak aphid population was noticed in 6th SMW in IPM plot (0.40 aphids/ leaf), non-IPM (1.50 aphids/ leaf) and 4th SMW in control plot (4.15 aphids/ leaf) depicted in table 7 and figure 3. In comparison to non-IPM plot there was 68.74 percent reduction of aphid population in IPM plot as per the t-statistical value given in table 8. The mean population of aphids was 2.79 ± 1.23 number in control plot which was 81.41 percent more than in IPM plot as per the t-statistical value shown in the table 9.

Red spider mites (*Tetranychus utricae*)

The data shown in the table 10 and figure 4, revealed that the okra crop in IPM plot was noticed with lower population levels of two spotted red spider mite (*T. utricae*) than in the non-IPM and control plot. The mean population of two spotted mites was 0.54 ± 0.28 number per sq.cm. leaf area in IPM plot of okra as compared to that of non-IPM plot with 1.03 ± 0.41 number, which was 46.60 percent less than in non-IPM plots. There was a significant difference in mites per sq. cm. leaf area as compared to that of IPM and non-IPM plots as per the t-statistical value given in the table 11. The mean population of mites in control plot was found 4.04 ± 2.71 number per sq.cm. leaf area which was 77.97 percent higher than in IPM plot as per the t-statistical value given in the table 12.

Table 1: Population of jassids in IPM, non-IPM and control plots of okra

SMW (No.)	Jassids per leaf				
	IPM	Non-IPM	Control	PR (%)in IPM over non-IPM	PR (%) of IPM over control
48	2.45	3.26	3.30	25.16	26.07
49	1.85	2.95	4.57	37.21	59.43
50	2.74	5.48	6.90	49.97	59.99
51	2.37	5.36	7.16	55.79	66.49
52	2.99	5.94	8.70	49.64	65.29
1	2.34	5.78	8.97	59.32	73.43
2	3.33	6.29	9.64	46.66	64.86
3	3.03	6.06	10.26	49.69	69.68
4	3.31	6.30	10.60	47.07	67.98
5	3.05	6.00	11.23	49.04	72.08
6	3.61	6.40	11.83	43.09	68.56
Mean ±S.D	2.82 ±0.39	5.43 ±1.20	8.46 ±2.77	46.60	63.08

Table 2: t- statistical values for testing of significance of jassids in IPM and non-IPM plots of okra

Treatments	No. of jassids per leaf
IPM (Mean ±S.D)	2.82 ±0.39
Non-IPM (Mean ±S.D)	5.43 ±1.20
t cal.value	9.55
t tab.value	2.23
P value	0.00000009 (Significant)

Table 3: t- statistical values for testing of significance of jassids in IPM and control plots of okra

Treatments	No. of jassids per leaf
IPM (Mean ±S.D)	1.39 ±0.33
Control (Mean ±S.D)	8.46 ±2.77
t cal.value	8.37
t tab.value	2.23
P value	0.0000001 (Significant)

SMW - Standard Meteorological Week
IPM - Integrated Pest Management
PR- Per cent Reduction

Table 4: Population of whiteflies in IPM, non-IPM and control plots of okra

SMW (No.)	Whiteflies per leaf				
	IPM	Non-IPM	Control	PR (%)in IPM over non-IPM	PR (%) of IPM over control
48	0.64	0.88	0.77	27.27	16.88
49	0.43	0.82	1.43	47.56	69.93
50	0.47	1.07	2.97	56.07	84.17
51	0.39	1.03	3.10	62.14	87.42
52	0.44	1.12	4.30	60.71	89.77
1	0.35	1.09	4.40	67.89	92.05
2	0.42	1.29	6.53	67.44	93.57
3	0.36	1.25	6.97	71.20	94.84
4	0.40	1.43	6.73	72.03	94.06
5	0.34	1.40	6.57	75.71	94.82
6	0.38	1.52	6.27	75.00	93.94
Mean ± S.D	0.42±0.08	1.17±0.22	4.54±2.24	62.09	82.86

Table 5: t-statistical values for testing of significance of whiteflies in IPM and non-IPM plots of okra

Treatments	No. of whiteflies per leaf
IPM(Mean ± S.D)	0.42±0.08
Non-IPM(Mean ± S.D)	1.17 ±0.22
t cal.Value	8.88
t tab.Value	2.23
P value	0.0000004 (Significant)

Table 6: t-statistical values for testing of significance of whiteflies in IPM and control plots of okra

Treatments	No. of whiteflies per leaf
IPM (Mean ± S.D)	0.42 ± 0.08
Control (Mean ± S.D)	4.54 ±2.24
t cal. value	5.95
t tab. value	2.23
P value	0.0001 (Significant)

SMW - Standard Meteorological Week
IPM - Integrated Pest Management
PR- Per cent Reduction

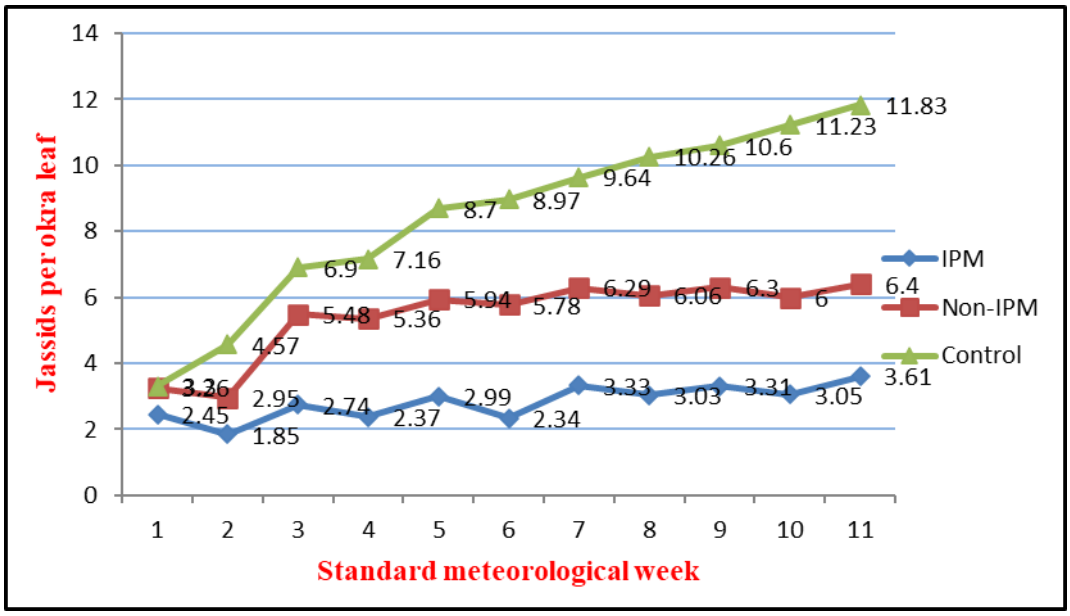

Fig 1: Population of jassids in IPM, non-IPM and control plots

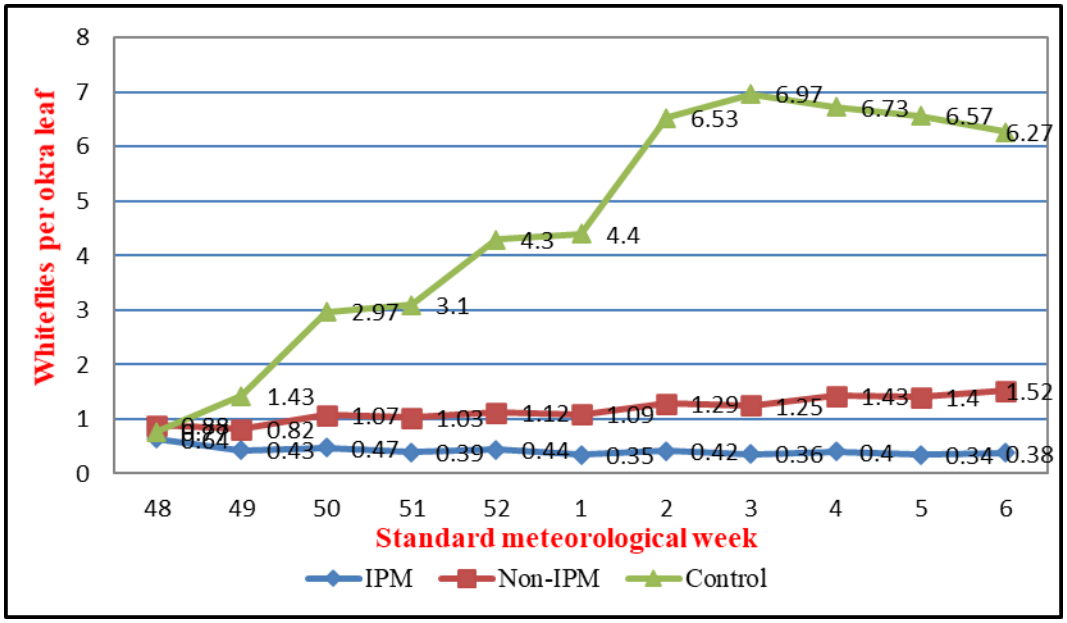

Fig 2: Population of whiteflies in IPM, non-IPM and control plots

Table 7: Population of aphids in IPM, non-IPM and control plots of okra

SMW (No.)	Aphids per leaf				
	IPM	Non-IPM	Control	PR (%)in IPM over non-IPM	PR (%) of IPM over control
48	0.00	0.00	0.00	-	-
49	0.22	0.92	1.97	76.09	88.83
50	0.33	1.12	2.15	70.54	84.65
51	0.24	1.06	2.28	77.36	89.47
52	0.32	1.22	2.43	73.77	86.83
1	0.25	1.15	2.67	78.26	90.64
2	0.34	1.31	3.38	74.05	89.94
3	0.29	1.28	3.97	77.34	90.55
4	0.35	1.38	4.15	74.64	91.57
5	0.26	1.35	3.97	80.74	93.45
6	0.40	1.50	3.82	73.33	89.53
Mean ± S.D	0.27 ±0.11	1.11 ±0.40	2.79±1.23	68.74	81.41

Table 8: t- statistical values for testing of significance of aphids in IPM and non-IPM plots of okra

Treatments	No. of aphids per leaf
IPM (Mean ± S.D)	0.27 ± 0.11
Non-IPM (Mean ± S.D)	1.11 ± 0.40
t cal. Value	9.13
t tab. Value	2.23
P value	0.0000003 (Significant)

Table 9: t- statistical values for testing of significance of aphids in IPM and control plots of okra

Treatments	No. of aphids per leaf
IPM (Mean ± S.D)	0.27 ± 0.11
Control (Mean ± S.D)	2.79 ±1.23
t cal. Value	7.26
t tab. Value	2.23
P value	0.000002 (Significant)

SMW - Standard Meteorological Week
IPM - Integrated Pest Management
PR- Per cent Reduction

Table 10: Population of mites per cm^2 leaf area in IPM, non-IPM and control plots of okra

SMW (No.)	Mites per cm^2 per leaf				
	IPM	Non-IPM	Control	PR (%)in IPM over non-IPM	PR (%) of IPM over control
48	0.00	0.00	0.00	-	-
49	0.00	0.52	0.92	100	100
50	0.55	1.14	2.06	51.75	73.30
51	0.49	1.08	2.33	54.63	78.97
52	0.62	1.14	3.03	45.61	79.53
1	0.58	1.10	3.76	47.27	84.57
2	0.69	1.22	4.51	43.44	84.70
3	0.64	1.19	5.44	46.22	88.23
4	0.76	1.32	6.23	42.42	87.80
5	0.71	1.28	7.81	44.53	90.91
6	0.86	1.36	8.30	36.76	89.64
Mean ± S.D	0.54 ±0.28	1.03 ±0.41	4.04 ±2.71	46.60	77.97

Table 11: t- statistical values for testing of significance of mites per cm^2 leaf area in IPM and non-IPM plots of okra

Treatments	No. of mitesper cm^2per leaf
IPM (Mean ± S.D)	0.54 ± 0.28
Non-IPM (Mean ± S.D)	1.03 ± 0.41
t cal. Value	9.84
t tab. Value	2.23
P value	0.0000001 (Significant)

Table 12: t- statistical values for testing of significance of mites per cm^2 leaf area in IPM and control plots of okra

Treatments	No. of mites per cm^2per leaf
IPM (Mean ± S.D)	0.54 ± 0.28
Control (Mean ± S.D)	4.04 ± 2.71
t cal. Value	4.69
t tab. Value	2.23
P value	0.0008 (Significant)

SMW - Standard Meteorological Week
IPM - Integrated Pest Management
PR- Per cent Reduction

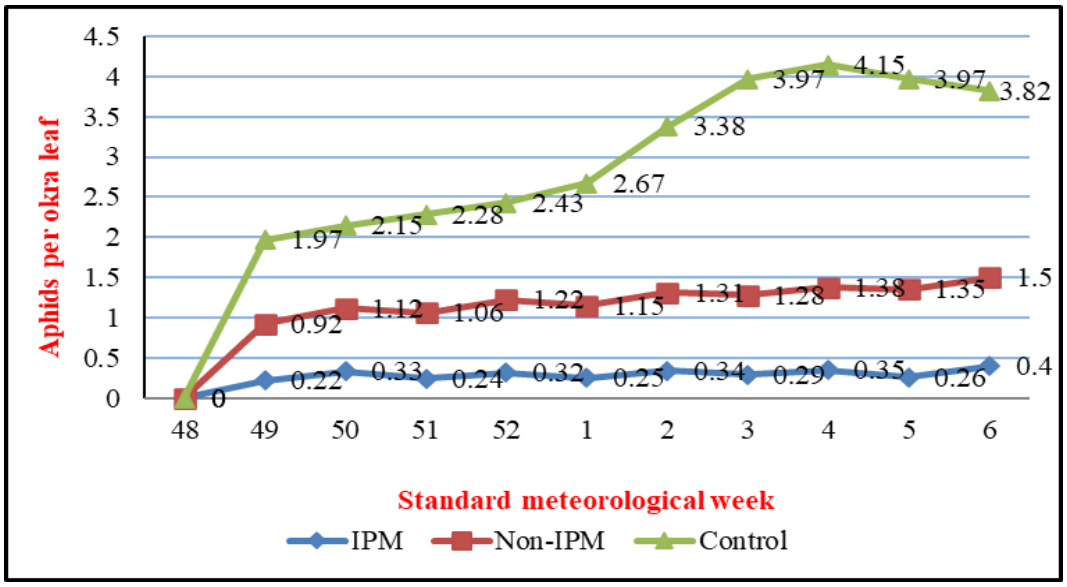

Fig 3: Population of aphids in IPM, non-IPM and control plots

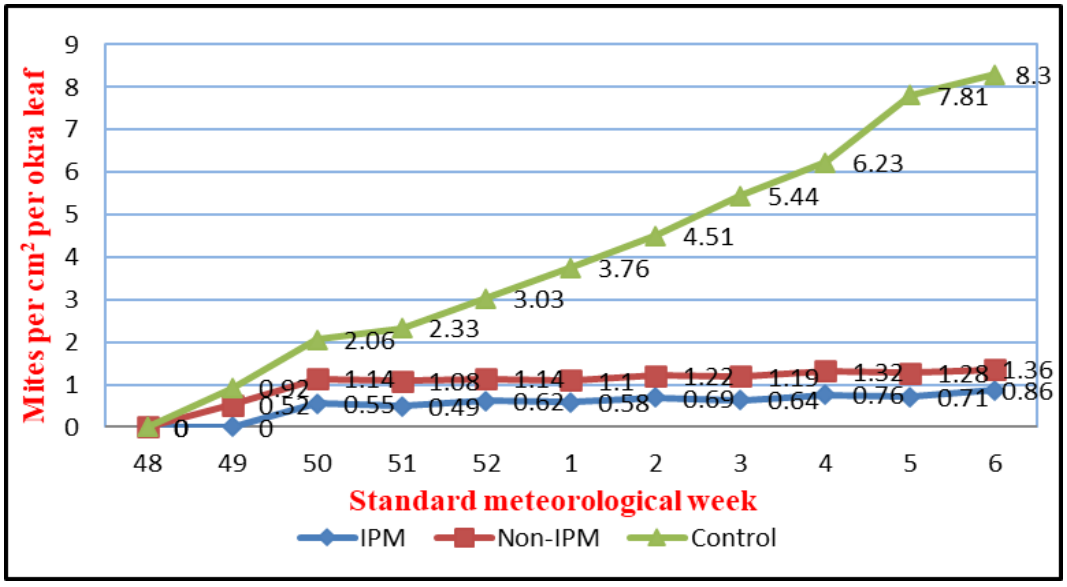

Fig 4: Population of mites per cm^2 leaf area in IPM, non-IPM and control plots

To sum up, in the present investigation, IPM has played a vital role in the management of sucking pest population of okra *viz.*, jassids, whiteflies, aphids, mites and the reduction of these pests in IPM plot over the non-IPM and control plots (fig. 5) was chiefly contributed by adoption of various IPM inputs namely, border crop, use of plastic mulch, sticky traps, pheromone traps, need based application of botanicals

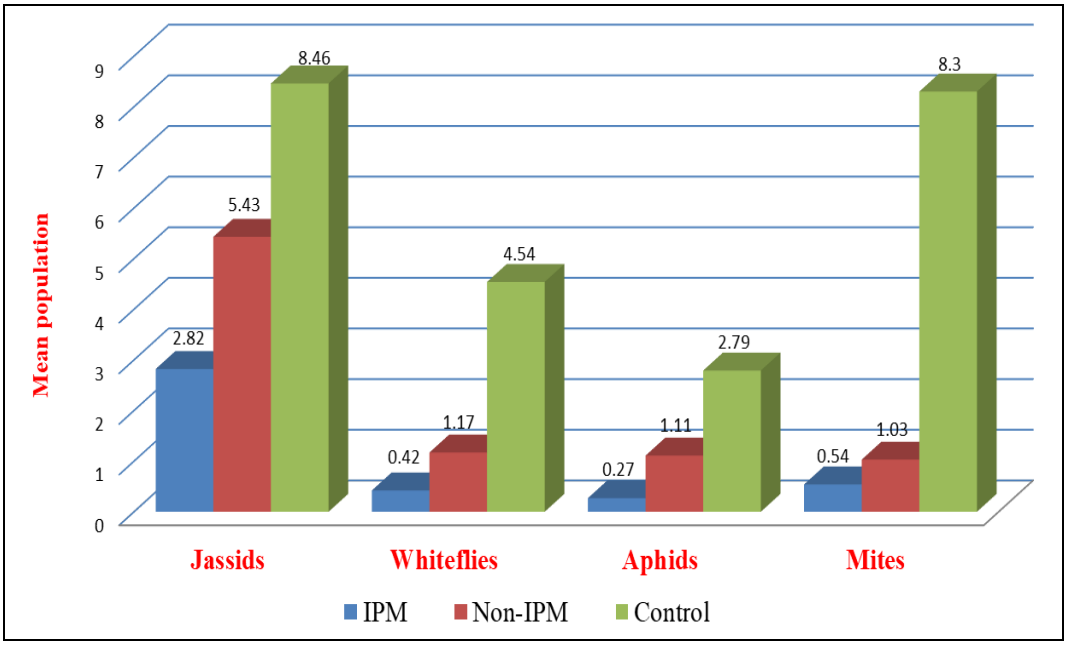

Fig 5: Comparison of mean of jassids, whiteflies, aphids and mites in IPM, non-IPM and control plots of Okra

Natural enemies (Spiders and coccinellids)

Beneficial insects play an important role in natural pest control and pollination. The use of synthetic pesticides has detrimental effects to both natural enemies and pollinators in agricultural and horticultural fields. The pesticides affect the survival of a range of life cycle (grubs and adults) stages, reducing their reproductive capacity, changes in the suitability of hosts for parasitizing or predation, reduced emergence of parasitoids from sprayed host eggs and cause direct mortality. Hence, in the present study the impact of IPM and non-IPM practices on natural enemy population of okra pests *viz.*, spiders and coccinellid beetles was recorded and presented here under.

The mean population of natural enemies *viz.*, spiders and coccinellid beetles were found 3.58 ± 2.39 per plant in IPM as compared to that of 2.70 ± 2.39 in non-IPM plot, which was 32.62 percent less than that of IPM plot of okra as indicated in table 13 and figure 6. The data shown in the table 14 depicted that there was a significant difference in number of natural enemies per plant between IPM and non-IPM plots as per the t-statistical value. While, in okra grown in control plot the mean number of natural enemies was 3.22 ± 2.48 which was 25.07 less than that of IPM plot of okra. Significant difference was found in natural enemies per plant between IPM and control plots of okra as per the t-statistical value shown in the table 15.

Table 13: Population of natural enemies in IPM, non-IPM and control plots of okra

SMW (No.)	Natural enemies per plant									PI (%)in IPM over non-IPM	PI (%) of IPM over control
	IPM			Non-IPM			Control				
	Spiders	Coccinellids	Total	Spiders	Coccinellids	Total	Spiders	Coccinellids	Total		
48	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-	-
49	0.00	0.40	0.40	0.00	0.00	0.00	0.00	0.00	0.00	100	100
50	0.60	0.62	1.22	0.40	0.00	0.40	0.45	0.20	0.65	63.11	46.72
51	1.20	1.65	2.85	0.85	0.10	0.95	1.05	0.50	1.55	66.67	45.61
52	1.35	1.76	3.11	1.25	0.35	1.60	1.45	0.76	2.21	48.55	28.94
1	2.50	1.95	4.45	2.35	0.76	3.11	2.40	0.95	3.35	30.11	24.72
2	3.80	2.05	5.85	3.50	1.15	4.65	3.70	1.85	5.55	20.51	30.00
3	5.85	1.80	7.65	5.35	1.55	6.90	5.65	1.60	7.25	9.80	5.22
4	5.20	1.40	6.60	4.90	1.60	6.50	5.05	1.40	6.45	1.51	2.27
5	3.45	0.86	4.31	3.10	1.00	4.10	3.20	0.86	4.06	4.87	5.80
6	2.70	0.42	3.12	2.20	0.36	2.56	2.50	0.52	3.02	17.95	3.21
7	2.15	0.25	2.40	1.60	0.12	1.72	2.00	0.20	2.20	28.33	8.33
Mean ± S.D	2.49±1.91	1.09 ± 0.75	3.58± 2.39	2.13 ± 1.80	0.57± 0.61	2.70 ± 2.39	2.29 ±1.86	0.93± 0.61	3.22 ±2.48	32.62	25.07

Table 14: t- statistical values for testing of significance of natural enemies in IPM and non-IPM plots of okra

Treatments	No. of natural enemies per plant
IPM (Mean ± S.D)	3.58± 2.39
Non-IPM (Mean ± S.D)	2.70 ± 2.39
t cal. Value	4.60
t tab. Value	2.20
P value	0.0008 (Significant)

Table 15: t- statistical values for testing of significance of natural enemies in IPM and control plots of okra

Treatments	No. of natural enemies per plant
IPM (Mean ± S.D)	3.58± 2.39
Control (Mean ± S.D)	3.22 ±2.48
t cal. Value	2.57
t tab. Value	2.20
P value	0.0008 (Significant)

SMW - Standard Meteorological Week
IPM - Integrated Pest Management
PI- Per cent Increase

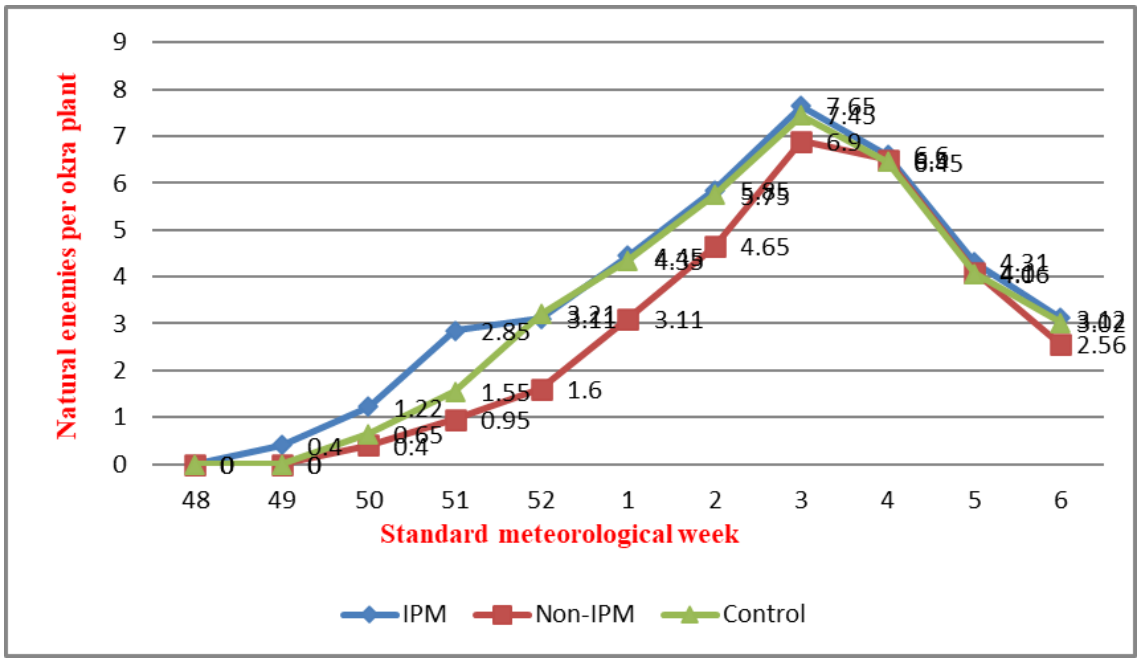

Fig 6: Population of natural enemies in IPM, non-IPM and control plots

The reduction in pest population in IPM plot was mainly attributed to various IPM components such as border crop (maize), yellow sticky traps, light trap, pheromone traps and need based application of botanical pesticides *viz.,* NSKE 5 percent at 48th SMW, neem oil @ 3ml/l at 50th SMW, 5 percent sweet flag aqueous extract at 52nd SMW and need based spraying of imidachloprid 17.8 SL @ 0.3 ml/l at 6th SMW. These results are in confirmation with the findings of Kumar *et al.* (2011) [4] and Ashfaque *et al.* (2016) [1] who reported less incidence of jassids in IPM grown okra plots than in non-IPM and control plots of okra. The results are also in agreement with Ashfaque *et al.* (2016) [1] and Sharma and Summarwar (2017) [10] who reported low incidence of whiteflies in botanical treated crops. In the present investigation, the aphid population build up was much lesser in the okra crop grown in IPM plot than in non-IPM and control plots which is in conformity with the reports made by Ursani *et al.* (2014) [13], Ashfaque *et al.* (2016) [1] and Zakir *et al.* (2017) [14]. Sruthi *et al.* (2018) [12] observed minimum incidence of mites in bio intensive module.

The minimal or nil mortality of the natural enemies was recorded in IPM plot and moreover their population was sustained and increased in the IPM plot as suggested by Praveen and Dhandapani (2001) [6] and Dutta *et al.* (2017) [3] which was 1.33 times more than that of non-IPM plot of okra. Whereas, in the non-IPM plot due to sequential spraying of synthetic chemicals the natural enemy population was reduced due to contact and residual toxicity. Mishra and mishra (2002) [5] and Rao and Raguraman (2005) [8] have also stated that natural enemy population was less in chemical treated plots than that of the plots sprayed with botanicals.

Conclusion

Thus, considering all the aspects of the present study okra crop grown in IPM plot was less infested with sucking pests *viz.,* jassids, whiteflies, aphids and mites as compared to that of non-IPM and control plots of okra. Implementation of IPM in okra have played a major role in conserving the natural enemies by improving their survival, reproductive, parasitization and predation ability than in the non-IPM and control plots of okra.

Acknowledgement

The author is thankful to Dr. Rajasekhar garu, Assistant Director, Animal husbandary, Kadapa District, Andhra Pradesh, India for providing me necessary facilities.

References

1. Ashfaque AN, Riaz M, Abdul GL, Muhammad MJ, Muhammad IB. Impact of IPM and traditional practices on okra plant, sucking complex and beneficial insects. European Academic Research. 2016; 3(10):11408-22.
2. Chaudhary HR, Dadeech. Incidence of insects attacking okra and the available losses caused by them. Annuals of Arid Zone. 1989; 28(3):305-07.
3. Dutta NK, Alam SN, Amin MR, Kwon YJ. Effect of population reduction of sucking pests and lady bird beetle in eggplant field. 2017; 42(1):35-42.

4. Kumar R, Monga D, Nitharawal M, Jat SL, Kumhar KC. Integrated Pest Management (IPM) packages in Bt. Cotton at farmers participatory field. Journal of cotton research development. 2011; 25(2):243-47.
5. Mishra NC, Mishra SN. Impact of biopesticides on insect pests and defenders of okra. Indian Journal of Plant Protection. 2002; 30(1):99-101.
6. Praveen PM, Dhandapani N. Eco-friendly management of major pests of okra (*Abelmoschus esculentus* (L.) Moench). Journal of Vegetable Crop Production. 2001; 7(2):3-12.
7. Preety J, Bharucha ZP. Integrated pest management for sustainable intensification of agriculture in Asia and Africa. 2015; 6(1):152-82.
8. Rao NS, Raguraman S. Influence of neem based insecticides on egg parasitoid, *Trichogramma chilonis* and green lace-wing predator, *Chrysoperla carnea*. Journal of Ecobiology. 2005; 17(5):437-43.
9. Rawat RR, Sadu HR. Estimation of losses in growth and yield of okra due to *Empoasca devastans* (dist). and *Earias* spp. Indian journal of entomology. 1973; 35:252-54.
10. Sharma R, Summarwar S. Management of sucking insect pest complex of *Bt.* cotton by Integrated pest management (IPM). International journal of advanced research and development. 2017; 2(4):105-07.
11. Siemonsma JS, Kouame C. Vegetables. In: Plant resources of tropical Africa 2 (Grubben GJH &Denton OA Eds.) PROTA Foundation, Wageningen, Agriculture and Biological Journal of North America. 2004; 4(5):532-38.
12. Sruthi M, Gopali JB, Mastiholi AB, Vasant MG, Shashi KS, Mahesh YS. Evaluation of IPM modules for the management of sucking pests of capsicum under protected condition. Journal of Entomology and Zoology Studies. 2018; 6(4):1362-68.
13. Ursani TJ, Malik S, Chandio JI, Palh ZA, Soomro NM, Lahari KH. Screening of biopesticides against insect pests of brinjal. International journal of emerging trends in science and technology. 2014; 1(6):918-31.
14. Zakir AB, Fida M, Abid AS, Maqsood AC. Integrated pest management of okra insect pests. International Journal of Fauna and Biological Studies. 2017; 4(3):39-42.